MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2017/2018

EEE3096 – COMMUNICATION ELECTRONICS
(TE)

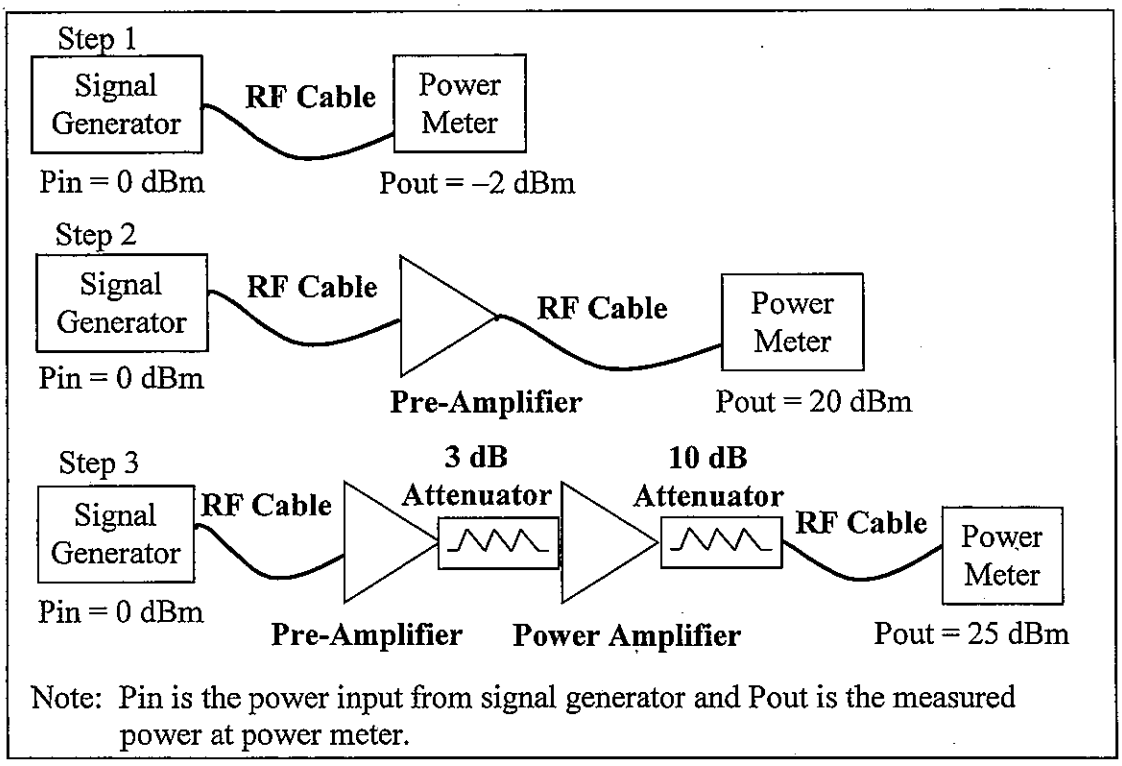
1 JUNE 2018
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 4 Questions only.
2. Attempt **ALL FOUR** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) The procedures of measuring gain for a power amplifier are illustrated below (Figure Q1a) :



Note: Pin is the power input from signal generator and Pout is the measured power at power meter.

Figure Q1a

(i) State a reason of using a pre-amplifier in the above measurement.

[2 marks]

(ii) State a reason of using an attenuator in the above measurement.

[2 marks]

(iii) What are the power losses contributed by the RF cables?

[2 marks]

(iv) Determine the gain of the pre-amplifier.

[2 marks]

(v) Determine the gain of the power amplifier.

[2 marks]

(Hints : Ignore the loss of connectors)

(b) A cascaded attenuator shown in Figure Q1a is used to reduce the source voltage to load R_L. It is required that the image impedance looking into the input of the attenuator be equal to the load resistor, such as $Z_i = R_L$. Determine the values of R_1, R_2, R_3 and R_4.

[10 marks]

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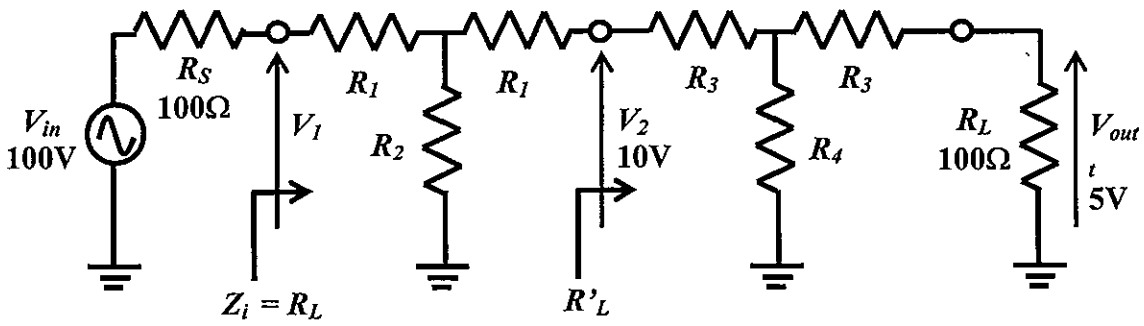

Figure Q1b

(c) Consider the unloaded parallel resonant RLC circuit shown in Figure Q1c. Calculate the resonant frequency, Q and 3-dB bandwidth.

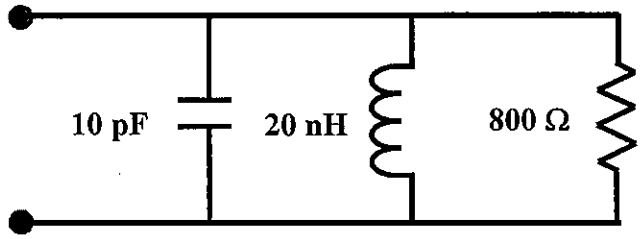

Figure Q1c

[5 marks]

Question 2

Consider the circuit in Figure Q2. The base spreading resistance, $r_{bb'}$ = 40 Ω, small signal current gain, h_{fe} = 200, early voltage, V_A = 50 V, collector-junction capacitance, C_C = 2 pF, transition frequency, f_T = 250 MHz at I_c = 3.3 ~ 5.0 mA, resonance frequency, f_0 = 20MHz, V_{BE} = 0.7 V, R_{b1} = 10 kΩ, R_{b2} = 5 kΩ, R_e = 200 Ω, L = 0.8 μH, R_L = 1 kΩ and V_{CC} = 5V.

(i) Draw the DC equivalent circuit and then determine the DC collector current, I_C.

[5 marks]

(ii) Draw the hybrid-π circuit employing Miller capacitance. Label all the elements.

[3 marks]

(iii) Determine the value of C at f_0.

[2 marks]

(iv) Find the voltage gain, A_v (in dB) at f_o.

[15 marks]

Continued .....

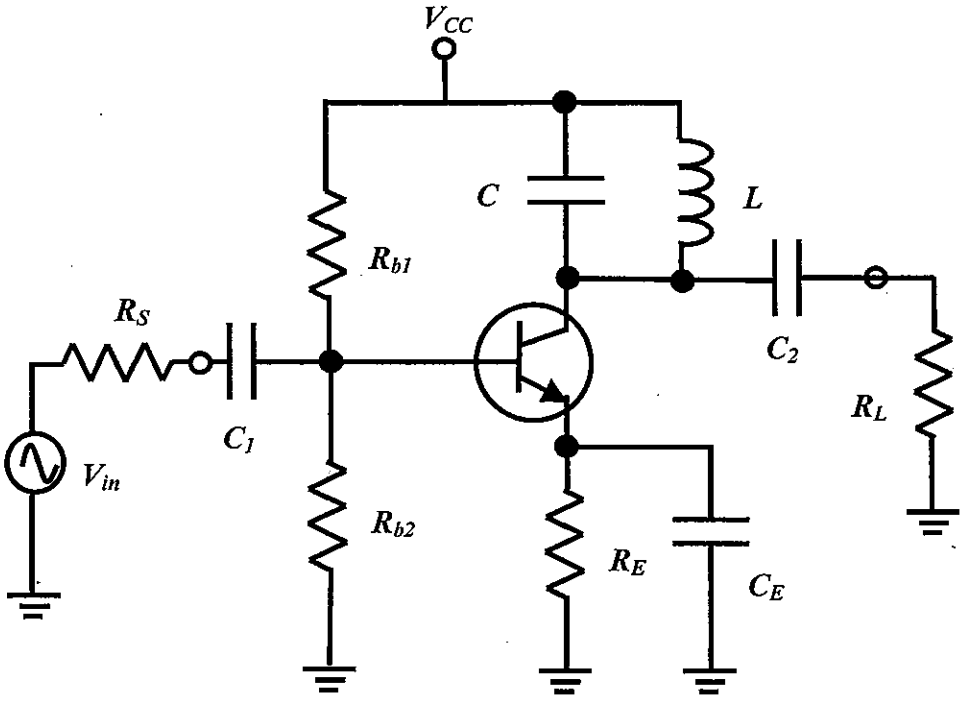

Figure Q2

Question 3

(a) Define Sketch the block diagram of a phase lock loop (PLL) and briefly explain the functions for each components of the PLL.

[4 + 8 marks]

(b) Figure Q3b shows a frequency synthesizer used for channel selection in a superheterodyne receiver.

(i) Explain the rationale for having the "÷2000" and pre-scaler frequency divider.

[2 + 3 marks]

(ii) Determine N for an VCO output of 204.8 MHz.

[4 marks]

(iii) Determine the PLL open loop gain when the output is 204.8 MHz.

[4 marks]

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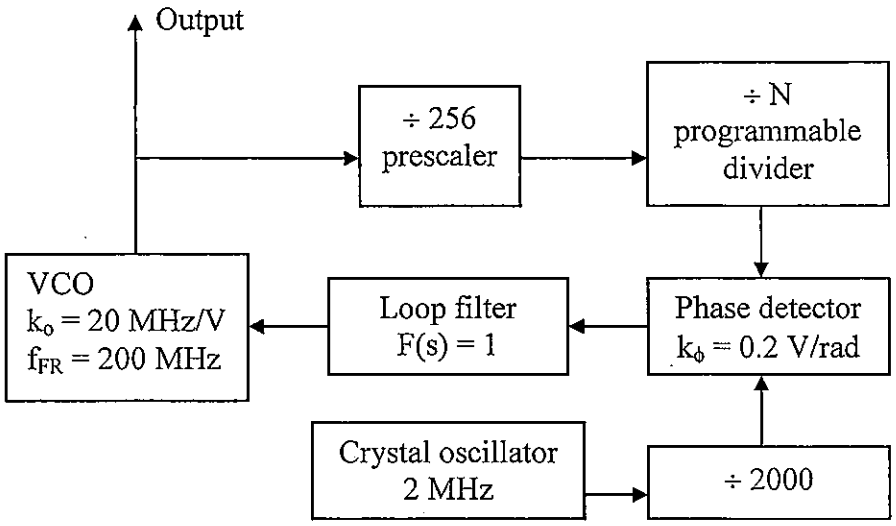

Figure Q3b

Question 4

(a) A television receiver with IF frequency of 40 MHz is tuned to a channel frequency of 90 MHz. Determine the following:

(i) The local oscillator frequency and its respective image frequency if high side injection is used.

[4 marks]

(ii) The local oscillator frequency and its respective image frequency if low side injection is used.

[4 marks]

(b) Explain the basic working principle of gated automatic gain control (AGC). Explain why gated AGC is preferred over AGC using averaging or peak detector in television (TV) receivers.

[7 marks]

(c) A monochrome TV channel is allocated a 6 MHz bandwidth. Using suitable diagrams, explain how chrominance information is fitted into the same 6 MHz bandwidth for colour TV transmission and why it is possible.

[6 marks]

(d) Given that National Television System Committee (NTSC) defines a frame rate of 30 fps with 525 lines per frame. Determine the field and line frequency.

[4 marks]

Continued .....

Appendix – Useful Formulas

1. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	**The base-spreading resistance.**
g_m	**The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, $1.6\text{x}10^{-19}$C
C_e	**The emitter capacitance.**
$r_{b'e}$	**The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	**The collector to base resistance.** $r_{b'c} = h_{fe}r_{ce}$
C_C	**The collector capacitance.**
r_{ce}	**The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

2. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'}r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'})r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o)C_C$.

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

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